Gas Chromatography

Gas chromatography (GC) is used for the qualitative and quantitative analysis of inorganic and organic gases or liquids with boiling points below 500°C. Both polar and nonpolar species can be analyzed.

Principle of Technique

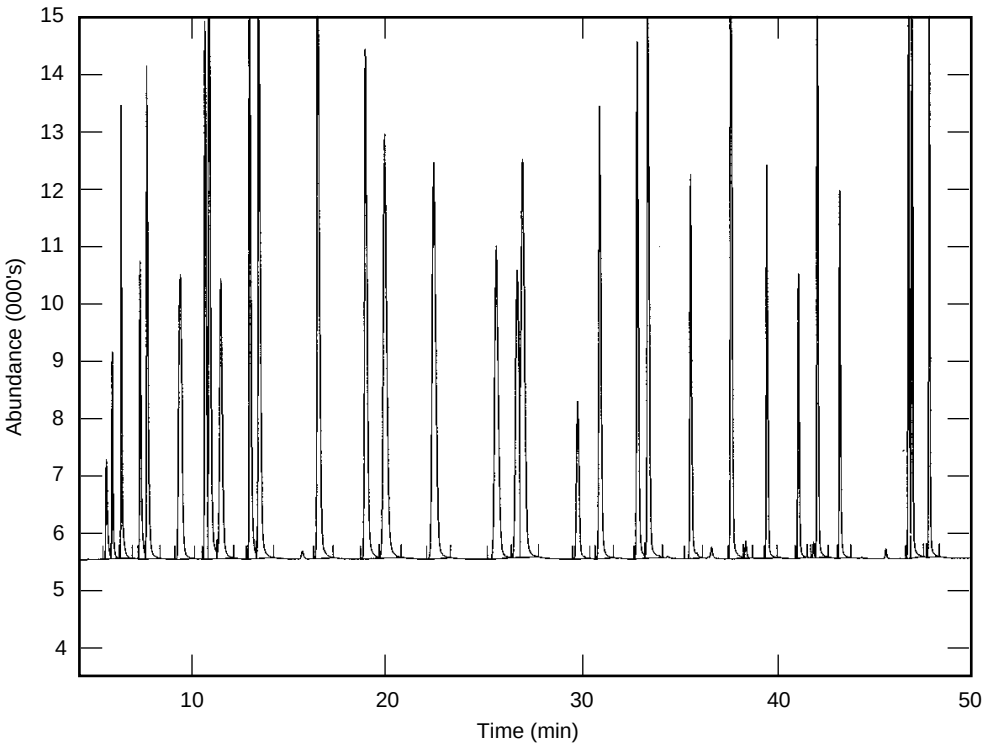
Gas or volatilized liquid is injected through an injection port into a flowing stream of inert carrier gas such as helium, argon, or nitrogen. The sample and carrier gas pass through columns that contain a stationary phase. The sample components are separated through sorption or gas–liquid partitioning. The separated components are flushed sequentially from the column and through a detector; thermal conductivity, flame ionization, and electron capture detectors are the most common types. The elapsed time from injection to detection is the retention time for individual species.

Identification of the individual components and quantification are achieved by comparing the retention times and peak areas of the sample with those of reference standards.

Samples

Form. Liquids or gases.

Size. For liquids, the amount needed can vary from 0.5 mL for unknown mixtures to 0.1 mL for familiar ones. A minimum of 5 mL at standard temperature and pressure (STP) of gas is required, although larger samples are preferred for trace analysis. Typically, a quantity of several liters of gas at STP is desirable.



Examples of Applications

- Analysis of high purity gases for contaminants.
- Quantitation of specific compounds in liquid or gaseous mixtures.
- Fingerprints and simulated distillations of retort oils can be determined.
- Environmental screening for volatile organic compounds in water.
- Screening for gasoline/diesel oil in extracted soil or water samples.
- Characterization and quantitation of breakdown products for shale oil research projects.
- Measurement of percent composition and purity of liquid explosives.

GC is used to perform EPA Method 8010/8020 analyses to measure volatile halogenated and volatile aromatic compounds in environmental samples.

Preparation. Most samples can be analyzed as received; some samples (e.g., water) may be subjected to prior extraction.

Limitations

Inorganic gases have limits of detection in the low ppm range. Specific species of organic compounds have parts-per-billion limits of detection that are easily obtained. However, it may be difficult to identify components in complex mixtures. Mixtures that contain corrosive or reactive compounds cannot be analyzed because of reactions with columns and other instrument components.

Estimated Analysis Time

Instrument calibration may require several hours. Once calibration is completed, most gases can be analyzed in less than 30 min. Analysis of liquid samples may require 15 min to more than 4 h, depending on the complexity of the mixture. Overall time for an analysis is approximately the same as instrument time, unless columns and conditions are unknown or extensive sample preparation is needed. In these cases, a new method must be developed. Additional time may also be required for preparation of standards for quantitative analysis.

Capabilities of Related Techniques

Other variations of chromatography such as high performance liquid chromatography (HPLC) may be useful for some liquids and solids.

Supercritical fluid extraction and chromatography (SFE-SFC) using carbon dioxide and nitrous oxide and flame ionization detection or ultraviolet detection may also be used. SFE-SFC can be used on solid materials and viscous liquids.

GC-mass spectrometry (MS), GC-MS-MS, GC–infrared, or nuclear magnetic resonance spectroscopy may yield better identification of components in unknown samples.

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